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CAN I HEAR YOU?

A DESCRIPTIVE LONGITUDINAL STUDY OF HEARING LEVELS OF AEROMEDICAL TECHNICIANS AND FLIGHT NURSES

by

Mary Gene Guzinski/Ryan, BSN, Capt., USAF, NC

THESIS

Presented to the Faculty of The University of Texas Health Science Center at Houston School of Public Health in Partial Fulfillment of the Requirements for the Degree of

Master of Public Health

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TO MY FATHER AND MOTHER --

WHO LET ME BE MYSELF

AND

TO BOBBY --

WHO GIVES ME A REASON TO BE.

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CAN I HEAR YOU?

A DESCRIPTIVE LONGITUDINAL STUDY OF HEARING LEVELS OF

AEROMEDICAL TECHNICIANS AND FLIGHT NURSES

Mary Gene Guzinski Ryan, BS, Capt., USAF, NC
The University of Texas, 1980

Supervising Professor: Clayton W. Eifler

This study was designed to describe the hearing levels of both flight nurses and aeromedical technicians over time. A computer printout was received from the USAF Hearing Conservation Registry which depicted a three year period as the longest consecutive period with a sufficient population. From the data received, 60 aeromedical technicians' and 62 flight nurses' hearing levels were examined. Both flight nurses and aeromedical technicians showed stable hearing levels with no apparent hearing threshold shift to indicate noise-induced hearing loss.

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CHAPTER I

INTRODUCTION

Can I hear you? For a (USAF) United States Air Force flight nurse or a USAF medical technician in aeromedical evacuation, noise is a major part of the environment. They deliver patient care within hazardous noise exposure levels both on the ground (flightline) and in flight. The acuity with which they can perceive sound is important to the determination and the communication of the patient's health needs and status. Their ability to make these determinations and communications is hindered by the noise levels in which they work. The noise levels are generally higher in the cargo section (aft area) of the aircraft as compared to the (forward area) cockpit section (Gasaway, 1970a:7-13). It is within the cargo section where flight nurses and medical technicians administer patient care. Also, it is here where they are exposed to the high levels of noise. The purpose of this study is to describe the longitudinal effect of noise on flight nurses and medical technicians from which further hypotheses can be made. This study will be accomplished by a comparison of 62 flight nurses' and 60 medical technicians' audiograms taken before exposure to aircraft noise with three consecutive annual audiograms while in an aeromedical evacuation assignment.

Statement of the Problem

This is a descriptive longitudinal study to determine the hearing acuity of flight nurses and medical technicians exposed to hazardous noise in the aeromedical evacuation system over time. This study will also determine if the hearing acuity differs between the two groups.

Justification of the Problem

Patient care is administered by flight nurses and medical technicians in the cargo section of the C-9, C-141 and C-130 aircraft. In all these aircraft the noise levels are greater in the cargo section. To date only one study has attempted to determine if the hearing acuity of aeromedical evacuation flight nurses has been affected by the noise exposure in the cargo section during flying assignments. A loss was noted in hearing acuity at the 4000Hz and 6000Hz frequency range. The loss was determined by a comparison of only one annual audiogram to the reference audiogram. Neither an accurate description of the hearing levels nor a trend toward hearing loss could be assumed based on that one measurement and one comparison. No study has ever been done, specifically, concerning the hearing levels of aeromedical evacuation technicians. This study will describe the hearing levels of both the flight nurses and aeromedical technicians over a period of time. By this description, a trend will or will not be shown towards noise induced hearing loss and a more accurate hypothesis can then be tested.

Scope and Limitations

The population was 62 flight nurses and 60 medical technicians, classified as being on flight status, whose AF Forms 1490, (see Definition Section) were received by the USAF Hearing Conservation Data Registry, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas for a consecutive three year period. Information not under the control of the investigator was:

1. The environment where audiograms were taken
2. The actual calibration of the audiometers
3. Whether the person was active duty or reserve duty
4. The primary aircraft and number of flying hours the person actually had experienced
5. The consistency of recording the data and reporting to the USAF Hearing and Conservation Data Registry

This information would be valuable to control bias, but it is the researcher's opinion that the absence of the information will not be critical. The above information is not reported on the AF Form 1490. Therefore, the data will show the best description possible at this time of the hearing levels of the aeromedical evacuation flight nurses and technicians.

Definition of Terms[1]

Aeromedical Evacuation Aircraft.--An aircraft used to airlift patients to and from medical treatment facilities.

Aeromedical Technician.--One who performs patient care and other medical technician functions.

Aircraft Engines:

Reciprocal Engine.--An internal combustion engine in which the heat energy of the fuel drives pistons in a linear motion within a cylinder. It is a piston engine which turns a propeller.

Turbofan Engine. A jet-like engine which produces increased thrust by a large, cold-air fan accelerating and expelling a large volume of cool air in a process separate from regular engine operation.

Turbojet Engine.--A high-velocity jet exhaust which propels an aircraft without the use of a propeller.

Turboprop Engine.--Propeller driven by a gas turbine.

Air Force Form 1490.--Hearing Conservation Data form (Appendix A); the primary tool used in this study to collect data for comparison of current audiograms to reference audiograms.

Air Force Specialty Code (AFSC).--A digital code used to identify Air Force occupations. Some have an alphabetical coded suffix and/or prefix. It is used to help to identify people qualified for assignment to bases where a specific need for trained personnel exists.

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[1] Cynthia Smith, A Comparison of Hearing Levels of Flight Nurses Before and During Flying Assignments, (USAF School of Aerospace Medicine, Aerospace Medicine Division (AFSC), Brooks Air Force Base, Texas. 1976), p. 3-8.

Audiogram.--A graphic or numeric display of a person's hearing levels, measured in decibels as a function of frequency (Hertz).

Types of Audiograms:

Current Audiogram.--The audiogram taken at the time of completion of a form--as opposed to a reference audiogram transcribed from a previous record. Current audiograms may be one of the following types:

90-day Audiogram
The 90-day audiogram is accomplished after an individual has been exposed to a hazardous noise for 90 days. The purpose is to detect individuals susceptable to hearing change as the result of noise exposure.

Annual Audiogram
Annual audiograms are performed at least once each 12 months on all personnel who work in noise environments that are considered potentially hazardous to unprotected ears. Annual audiograms are compared to reference audiograms to determine the presence of a threshold shift.

15-hour Audiogram
The 15-hour recheck audiogram is done on individuals showing a significant threshold shift on 90-day audiograms or annual audiograms. The individual must be removed from exposure to noise, below 75 dBA, for at least 15 hours before being retested.

40-hour Audiogram
The 40-hour recheck audiogram is done if the 15-hour recheck audiogram still reveals a threshold shift. The audiogram is repeated after a 40-hour period free from noise.

Reference Audiogram.--The audiogram against which more current audiograms are compared, ideally representing a person's hearing levels prior to noise exposure. Reference audiograms are classified into the following classes according to the hearing levels entered:

Reference Class A Audiogram.--Hearing threshold levels at 500, 1000, 2000, 3000, 4000, and 6000Hz, that do not exceed 25 dB at any test frequency, either ear.

Reference Class B Audiogram.--Hearing threshold levels at 500, 1000, 2000, 3000, 4000, and 6000Hz that are in excess of 25dB at one or more test frequencies, either ear, but do not average 30dB or more, for the frequencies of 500, 1000, and 2000Hz, either ear.

Reference Class C Audiogram--Hearing threshold levels at 500, 1000, and 2000Hz that average 30dB or more in either ear.

dBA or A-weighted scale.--A single scale (electronic weighting) that uses response characteristics that parallel a human ear at threshold. The A-weighted scale is most sensitive to sounds, or noises, present within the frequency range from 600 through 6000Hz and least sensitive to acoustic energy below 600Hz.

Decibel (dB).--A measure of sound intensity. Decibels are based on logarithms. It is a unit of sound-pressure.

Flight Nurse.-- One who performs patient care and other nursing procedures and functions in an aeromedical evacuation aircraft.

Hearing Level.--Threshold sensitivity for pure tone, or other sound, as measured with an audiometer. Given in decibels relative to average normal values as specified in whatever standard is applied.

Hearing Loss.--The hearing loss at a specified frequency in decibels, by which the threshold of audibility for that ear exceeds a standard audiometric threshold.

Hertz (Hz) and Cycles Per Second.--The number of cycles in sound pressure occurring in one second--the frequency of a pure tone.

Medical Examination for Flying Classifications.--

(1) Flying Class I--qualifies for either pilot or navigator training.

(2) Flying Class IA--qualifies for navigator training those applicants who cannot meet Class I visual or sitting height restrictions.

(3) Flying Class II--qualifies for flying duty those personnel who hold any of the following currently effective aeronautical ratings:

(a) Pilot, senior pilot or command pilot.

(b) Navigator, senior navigator or master navigator.

(4) Flying Class III--qualifies for flying duty those personnel who are not involved in primary control of aircraft:

(a) Flight surgeons, senior flight surgeons and chief flight surgeons.

(b) All other nonrated personnel who are ordered by competent authority to participate in frequent and regular aerial flight, such as flight medical officer, flight nurses and enlisted personnel.

Noise.--Noise is any undesired sound.

Noise-induced Hearing Loss.--A gradual loss of hearing of a sensorineural type occurring after years of exposure to hazardous noise.

Permanent Threshold Shift.--A permanent loss of the ability to detect weak auditory signals at a given frequency.

PNdB.--Perceived noise in decibels. A measure of the noisiness or annoyance value of noises.

Potentially Hazardous Noise.--Quantity, measured in decibels, of sound that over a specific period of time exceeds the auditory risk limit and may cause physical damage to the hearing mechanism.

Presbyacusis.--Impairment of hearing in old age.

Significant Threshold Shift.--Threshold shift large enough that special followup is required. The criteria for significant threshold shift are in AFR 161-35 and are:

(a) If the reference is Class A - Threshold shift is significant if it is 20dB or more at any frequency, either ear.

(b) If the reference is Class B or C - Threshold shift is significant if it is 10dB or more at 2000Hz, 15dB or more at 3000Hz, or 20dB or more at 4000Hz, or 6000Hz, either ear.

Sound Pressure Level (SPL).--Intensity of a particular sound measured in decibels.

Threshold Shift.--Change in hearing level between the reference and a current audiogram.

Preview of Methodology

A computer printout of current and reference audiograms on 62 flight nurses and 60 aeromedical technicians was obtained from the Hearing Conservation Data Registry, USAF School of Aerospace Medicine, Brooks AFB, Texas. The population consisted of nurses and medical technicians classified on flying status for the years 1976, 1977 and 1978, whose AF Forms 1490 were received by the USAF Hearing Conservation Data Registry. The annual audiograms from the years 1976, 1977 and 1978 were compared to reference audiograms to determine areas of loss or improvement at six test frequencies.

Sequence of Presentation

Chapter I consists of the introduction, statement of the problem, justification of the problem, scope and limitations, definitions of terms, preview of methodology, and sequence of presentation. Chapter II contains a review of the literature and the basis for the problem statement. Chapter III is a description of the methodology applied. Chapter IV is the analysis and discussion of the data. Chapter V contains a summary, conclusions, implications and recommendations.

CHAPTER II

Review of Literature

What is noise? Noise is actually a subjective assessment of sound. Sound is a wave producing changes in mass density, volume elasticity, and air pressure (Magrab, 1975:2). Noise can then be defined as an undesirable unwanted, intolerable, unpleasant or bothersome interference as perceived by a listener. So, how much noise is too much? L_{eq} is a basic description in calculated form of environmental noise (Stevens, 1975:154). Table 1 shows the typical average daily exposures of noise for various life styles within the United States for a twenty-four hour period (Stevens, 1975:157).

TABLE 1

TYPICAL AVERAGE DAILY EXPOSURES FOR LIFE STYLES (USA)

	$L_{eq(24)}=L_{dn}$*	
	Suburban	Urban
Preschool child	60dB	69dB
School child	77dB	77dB
Housewife	64dB	67dB
Office Wroker	72dB	70dB
Factory Worker	87dB	87dB

*$L_{eq(24)}$ - average sound level for 24 hours

L_{dn} = day-night average sound level

In Table 2, Gierke identifies the yearly average compatible noise levels with public health and welfare (Stevens, 1975:164).

TABLE 2

SUMMARY OF MAXIMUM NOISE LEVELS IDENTIFIED

REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE

EFFECT	LEVEL	AREA
Hearing Loss	$L_{eq(8)}$= 75dB	Occupational and educational settings
	$L_{eq(24)}$= 70dB	All other areas
Outdoor activity interference and annoyance	L_{dn}= 55dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(8)}$= 55dB	Outdoor areas where people spend limited amounts of time such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	L_{dn}= 45dB	Indoor residential areas
	$L_{eq(24)}$= 45dB	Other indoor areas with human activities such as schools, etc.

As can be seen, noise level exposure, according to the above summary, greater than 75dB could result over an eight hour period in some hearing loss. (i.e., temporary threshold shift which could lead to a permanent threshold shift.) The Occupational Safety and Health Act of 1970 set standards for permissible daily exposure to noise as follows in Table 3 (Harris, 1979:40-2).

TABLE 3

PERMISSIBLE NOISE EXPOSURE

Duration per day/hours	Sound Level dB(A)
8	90
6	92
4	95
3	97

TABLE 3-Continued

Duration per day/hours	Sound Level dB(A)
2	100
1½	102
1	105
½	110
¼ or less	115

These standards are set to protect the worker. It must be noted that hearing protection is not mandatory unless the above exposure levels are violated. The USAF has established a lower standard of 84dB for an eight hour period (Smith, 1976:16). To be qualified for an aeromedical crewmember assignment, the criteria established in <u>AFM 160-1, Medical Examination and Medical Standards</u> and <u>AFR 161-35</u> must be met. This entails a Flying Class III physical with a H-1 hearing profile (Appendix B). A Class C reference audiogram rejects an individual from flying status (Smith, 1976:18).

What is the environment of the aeromedical technician and the flight nurse? Within the aeromedical system, three aircraft are mainly utilizied on a routine basis. These are the C-130B (Hercules), the C-141A (Starlifter), and the C-9A (Nightingale). The causes or characteristics of noise that can be encountered at several points outside and within these aircraft are:

1. Basic power plant (i.e., turbojet, turboprop, turbofan)
2. Rotary propellers and rotors
3. Aerodynamics friction and/or boundary layer disturbances
4. Airflow and airducting from air conditioning pressurization and ram air system
5. Secondary auxiliary power units located inside or attached to main fusalage
6. Communication noise, electrical static background noise, extraneous secondary signal noises (Gasaway, 1970a:5).

The C-141A has four turbofan engines. High intensity noise levels within the patient (carbo/aft) section of the C-141A range from 87dB to 95dB on an A-weighted scale (Gasaway, 1970c:15). The C-9A has twin ducted fan engines. The measured noise levels during level flight at normal cruise speed ranged from 83dB to 92dB on an A-weighted scale (Gasaway, 1970b:16). The significance of these noise level ranges can be understood by comparing them with:

1. 75dB within 600 to 4000Hz decreases one's ability to clearly understand verbal communication (i.e., a shout at one foot of 95dB is not perceived by the listener).
2. 85dB for an eight hour noise level exposure is considered to be in the area of the hazardous boundary for unprotected ears. Ear protection is mandatory at standard levels set by the Occupational Safety and Health Act and by AFR 161-35 (Gasaway, 1970a:8).

According to Kryter in Effects of Noise on Man (1970), the sound pressure level (SPL) is depicted below in Table 4 for differing modes of transportation.

TABLE 4

MODES OF TRANSPORTATION

	SPL Range dB
Commercial Airliners	
Propeller Fixed Wing (fwd cabin)	58-105
Helicopter (aft cabin)	60-102
Jet - Fixed Wing (aft cabin)	55-88
Trolley and Motor Buses	50-81
Street and suburban railroad cars; city speeds, windows open. Automobile @ 60mph, smooth road, windows closed.	40-79

The C-130B, C-141A, and C-9A sound pressure levels fall within the above ranges taking into account the areas of the cabin (i.e., aft or forward) tested. As is shown, aircraft cabin sound pressure levels are higher than average commuting transportation vehicles. Therefore, the noise attributed to the aircraft will be higher.

Having discussed what excessive noise is, the question to be answered now is: How does this excessive noise affect the aeromedical technician and the flight nurse within the aeromedical evacuation system? According to Burns in his book Noise and Man (1973), there are three definite effects of noise on the acoustic perception of sound. The effects are temporary threshold shift, permanent threshold shift and acoustic trauma. Temporary threshold shift is a short-term loss of hearing which is reversible. A permanent threshold shift is a loss of hearing at a specific frequency which is non-reversible. This usually occurs after prolonged exposure to high intensity sound or noise levels. Acoustic trauma is a sudden damage to hearing from a short term exposure such as gunfire, fireworks, and small arms. To describe these further, the following examples are given:

1. An 80dB sound pressure level (SPL) at 2000Hz (frequency) after a ten year exposure will produce no shift.
2. An 88dB (SPL) will produce a 9dB shift.
3. A 95dB (SPL) will produce a 15dB shift (Burns, 1973:190).

These shifts are considered to be a permanent thr shold shift if they do not reverse to the reference audiogram after forty hours of non-exposure (Burns, 1973:190).

These threshold shifts can be monitored through a hearing conservation program where periodic audiological exams are given. Noice-induced hearing loss can be distinctly identified by its characteristic dip from the normal curve at 4000Hz. It returns to the normal curve at 6000Hz.

If no treatment is given (i.e., adequate ear protection and/or proper break times away from the hazardous noise), the noise-induced hearing loss will spread to the 3000Hz and 6000Hz frequencies. Presbyacusis without any noise-induced hearing loss has a characteristic dip at 6000Hz, but it does not return to the normal curve. It continues to increase in the loss at the higher frequencies (May, 1978:259-261).

Does noise just affect hearing? At the present time, according to both Kryter in the Effects of Noise on Man (1970) and Burns in Noise and Man (1973) and within several symposia and conferences, no definitive correlation between noise and psychological effects can be made. In the final analysis of the data, the variable noise was not isolated out as a single variable within the studies or experiments. Also, both perception of sound and psychological "normal" are subjective. Subjective variables are difficult to measure and describe objectively.

Physiological effects which are non-auditory have been documented. Stimulation to the ear causes effects within the cortical and subcortical brain centers, the autonomic nervous system and the reticular nervous system (Kryter, 1970:487). Kryter has formulated six properties of the ear and auditory sensory system which are:

1. The ear is more sensitive to sound than any other part of the body.
2. The ear will only send signals through impulses not physical energy to other parts of the body.
3. The ear will be damaged first by excessive amounts of noise before other areas of the body will be affected.
4. The ear will not generate signals that will harm the body.
5. The integrity of the parts and mechanisms of the organism will tend to be maintained or strengthened as a result of responding to normal stimulation.
6. Responses of the parts and mechanisms of organisms that serve no useful propose will tend to be inhibited by the organism (Kryter, 1970:489).

These six properties must be considered when analyzing effects of noise. Sound pressure level (SPL) can be significantly harmful or adverse to some individuals. As defined by Kryter, an N-response is a complex of responses to sound which is elicited by an SPL of 70dB at 1000Hz and includes:

1. A blood circulatory response primarily of vasoconstriction
2. Slow deep breathing
3. Change in resistence of skin to electricity
4. Skeletal muscle tension change (Kryter, 1970:338).

Through the use of N-response as an outcome, a study of noise and the effects on the endocrine system was carried out. Findings were that both pleasant and unpleasant stimuli due to sound caused increased excretion of catecholamines. Work in industrial noise and office work increased catecholamine excretion. It is interesting to note that the subject's attitude has a greater influence on excretion of catecholamines than did noise, light, or the task involved (Kryter, 1970:504).

Gastrointestinal mobility has been shown to increase in conjunction with high intensities of SPL and visual light. Continued exposure results in an adaptation to the stimulus (Kryter, 1970:496).

Hypertension and coronary heart disease have been studied in conjunction with culture and noise, and with work area and noise. The studies have shown increases in both hypertension and coronary heart disease where noise was a predominent environmental factor (Kryter, 1970:509 and Welch and Welch, 1970:58).

Other non-auditory physiological effects are:

1. Epinephrine and norepinephrine increase when controlled subjects are exposed to noise.

2. Central nervous system induces convulsions after exposure to specific levels of noise in susceptible individuals.

3. Vision is affected by noise in the forms of: nystagmus, vertigo, disruption in equilibrium, audio-analgesic response influenced by the galvanic skin response.

4. Fetal heart rate and activity increases with noise stimulation (Welch and Welch, 1970:53,139,147,251).

The pathophysiology in the above changes is not yet completely understood, and must be considered when assessing noise as a factor.

Although all sounds are not unpleasant at high intensities in a work or home environment, Jansen and Klensch have shown that the audiological responses to pleasant music and to unpleasant noise were similar. Presumably it was not whether the sound was annoying, but rather, the actual sound pressure level (SPL) of the music or noise which caused the audiological responses (Kryter, 1970:504).

This study is concerned with the effects over time of hearing acuity in both flight nurses and aeromedical technicians. One study was carried out specifically for flight nurses to determine hearing loss (Smith, 1976: 1-35). During the same year, one other study was done which incorporated portions of the same data used in Smith's study. Each showed some significant threshold shift in some of the flight nurses, but showed overall a decrease in hearing acuity at the 4000Hz and 6000Hz frequencies. (The frequencies at which noise induced hearing loss is commonly detected first). The data in each study was limited and the description of hearing loss could only be implied. The hearing loss shown could have been a temporary threshold shift.

In order to evaluate hearing loss in a group of individuals it would be more accurate to evaluate the group over time. It must be noted that there has not been a study done specifically to describe the hearing acuity of the aeromedical technician. From the review of the literature, it is evident that a clearer, more accurate description is needed concerning the hearing acuity of both the flight nurses and the aeromedical technicians.

CHAPTER III

METHODOLOGY

The study was conducted at Brooks Air Force Base, Texas. The Chief of Audiology and Hearing Conservation Function provided seven computer print-outs of:

a. Total number of both flight nurses and aeromedical technicians who had audiograms from 1975 - 1979 with a breakdown by year and type of audiogram per person.

b. The number of flight nurses and their consecutive audiograms for 1976, 1977, 1978 compared with their reference audiogram.

c. The number of medical technicians and their consecutive audiograms for 1976, 1977, 1978 compared with their reference audiogram.

d. The age specific median and mean values for both the current and reference audiograms. Also, computed were the threshold shift medians and means for the flight nurses.

e. The age specific median and mean results for both the current and reference audiograms of the medical technicians. Also, computed were the threshold shift mean and median results.

f. The combined data of median and mean values for both current and reference audiograms in 1976, 1977, and 1978 respectively for the flight nurses.

g. The combined data of median and mean values for both current and reference audiograms in 1976, 1977, and 1978 respectively for the medical technicians.

The population of flight nurses ranged in age from 25 - 49 for 1976, 25 - 50 for 1977 and 25 - 51 for 1978. They were all classified as being on flying status for the consecutive years 1976, 1977 and 1978, and their AF Forms 1490 were received by the USAF Hearing Conservation Data Registry. Out of 198 flight nurses with three or more annual audiograms only 62 (31.31%) had annual consecutive audiograms for the years 1976, 1977, 1978. The population of aeromedical technicians ranged in age from 19 - 54 for 1976, 20 - 54 for 1977, and 20 - 54 for 1978. They were all classified as being on flying status for the consecutive years 1976, 1977 and 1978, and their AF Forms 1490 were received by the USAF Hearing Conservation Data Registry. Out of 155 aeromedical technicians with three or more annual audiograms, only 60 (38.71%) medical technicians had annual consecutive audiograms for the years 1976, 1977, and 1978. No information on the length of time on flying status was available. The researcher felt that the data which was the only collected and recorded data base within the USAF was the most representative of the total flight nurse and medical technician population. Therefore, the data collected is felt to be sufficient to answer the problem statement in describing the hearing levels of both the flight nurses and the medical technicians who are subjected to hazardous noise levels and to describe any trends and differences which appear.

Since the Hearing Conservation Data Registry records all information from AF Form 1490 on computer tape, this was the data collection to be utilized. Each AF Form 1490 specifically states the reason for each audiogram recorded. Annual audiograms are done routinely as follow-up examinations for those who work in a hazardous noise work area. Each AF Form 1490, also, contains the reference audiogram to which the annual audiogram is compared. The reference audiogram originates from the medical records of each person. Threshold shift is then computed and designated as significant or not significant by the criteria in AFR 161-35 (see significant threshold shift in definition section).

The determination of threshold shift was computed and designated by computer scoring rather than examiner scoring. The computer printout consisted of median and mean values of current and reference audiograms, and median and mean threshold shifts of the age specific populations. Data were from a three year consecutive period beginning 1 January 1976 and ending 31 December 1978. These data were collected in February 1980.

CHAPTER IV

ANALYSIS AND DISCUSSION OF DATA

The population consisted of 62 flight nurses and 60 aeromedical technicians who were on flying status for the three consecutive years of 1976, 1977 and 1978. Each had a reported AF Form 1490 which was received by the USAF Hearing Conservation Data Registry, USAF School of Aerospace Medicine, Brooks AFB, Texas. There were 198 flight nurses on flying status within the time frame of 1975 through June of 1979 with three consecutive audiograms. Of these, 62 flight nurses had reported audiograms for the years 1976, 1977 and 1978. The sex distribution was 10 (16.13%) males and 52 (83.87%) females. The age distribution is depicted in Table 5.

TABLE 5

AGE DISTRIBUTION OF FLIGHT NURSES

1976

AGE		N	RELATIVE %	CUMULATIVE %
25-29		10	16.13	16.13
30-34		25	40.32	56.45
35-39		19	30.65	87.10
40-44		5	8.06	95.16
45-49		3	4.84	100.00
	Total	62		

TABLE 6

AGE-SPECIFIC DISTRIBUTION OF REFERENCE AUDIOGRAM CLASSIFICATION FOR FLIGHT NURSES

AGE GROUP		CLASS A	CLASS B
25-29		10	0
30-34		18	7
35-39		14	5
40-44		3	2
45-49		2	1
	Totals	47	15

Of these 62 flight nurses in Table 5, there were 47 flight nurses with a Class A reference audiogram and 15 with a Class B reference audiogram. The age-specific distribution of the reference audiogram classification is depicted in Table 6.

Table 7 shows the number of flight nurses with age-specific threshold shifts by reference audiogram classification for the years 1976, 1977 and 1978. The age-specific data are in ten year age groupings instead of five year age groupings as the numbers per cell were too small to be reported. The numbers were unaffected by this change.

TABLE 7

AGE-SPECIFIC THRESHOLD SHIFTS OF FLIGHT NURSES

	1976		1977		1978	
AGE	CLASS A	CLASS B	CLASS A	CLASS B	CLASS A	CLASS B
25-34	0	0	0	0	1	1
35-44	2	1	1	1	1	4
45-54	1	0	0	0	0	0
Totals	3	1	1	1	2	5

TABLE 8

AGE DISTRIBUTION OF AEROMEDICAL TECHNICIANS

1976

AGE	N	RELATIVE %	CUMULATIVE %
17-19	2	3.33	3.33
20-24	9	15.00	18.33
25-29	19	31.67	50.00
30-34	7	11.67	61.67
35-39	12	20.00	81.67
40-44	10	16.67	98.34
45-49	0	0	98.34
50-54	1	1.67	100.01
Total	60		

There were 155 aeromedical technicians on flying status within the time frame of 1975 through June of 1979 with three consecutive audiograms. Of these, 60 aeromedical technicians had reported audiograms for the years 1976, 1977 and 1978. The sex distribution was 56 (93.33%) males and 4 (6.67%) females. The age distribution for all is depicted in Table 8.

Of these 60 aeromedical technicians, there were 45 aeromedical technicians with a Class A reference audiogram for the years 1976 and 1977. There were 46 aeromedical technicians with a Class A reference audiogram for the year 1978. (This can be explained by a re-classification of the reference audiogram for one individual. It is felt that this would not unduly bias the data).

Those classified with a Class B reference audiogram were 15 aeromedical technicians for 1976 and 1977. In 1978, those with a Class B reference audiogram were 14 (this coincided with the one individual who was reclassified). The age-specific distribution of the reference audiogram classification is depicted in Table 9.

TABLE 9

AGE-SPECIFIC DISTRIBUTION OF REFERENCE AUDIOGRAM CLASSIFICATION FOR AEROMEDICAL TECHNICIANS

	1976		1977		1978	
AGE	CLASS A	CLASS B	CLASS A	CLASS B	CLASS A	CLASS B
17-19	2	0	0	0	0	0
20-24	5	3	6	0	3	0
25-29	17	3	19	5	22	4
30-34	7	0	7	0	7	0
35-39	7	5	5	3	5	2
40-44	7	3	7	6	8	5
45-49	0	0	1	0	1	2
50-54	0	1	0	1	0	1
Totals	45	15	45	15	46	14

Table 10 shows the number of aeromedical technicians with age-specific threshold shifts by reference audiogram classification for the years 1976, 1977, 1978. The age-specific data are in ten year age groupings instead of five year age groupings as the numbers per cell were too small to be reported.

TABLE 10

AGE-SPECIFIC THRESHOLD SHIFTS OF

AEROMEDICAL TECHNICIANS

	1976		1977		1978	
AGE	CLASS A	CLASS B	CLASS A	CLASS B	CLASS A	CLASS B
17-24	2	1	2	0	0	0
25-34	2	0	2	2	5	2
35-44	4	2	1	3	2	2
45-54	0	0	0	0	0	2
Totals	8	3	5	5	7	6

On examination of the age-specific data as compared to combined grouped data the same trend in the hearing levels was noted for both the flight nurses and aeromedical technicians. Therefore, the data to be presented as the description of the hearing levels of the flight nurses and the aeromedical technicians are the combined age median hearing levels and the combined mean threshold shifts.

Table 11 depicts for the flight nurses the median hearing levels of both the reference and annual audiograms for the years 1976, 1977 and 1978. Figure 1 depicts the median hearing level trend of the flight nurses for the years 1976, 1977 and 1978.

TABLE 11

MEDIAN* HEARING LEVELS FOR FLIGHT NURSES

IN dB

LEFT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	A	5.23	2.79	2.41	3.57	3.81	6.67
	R	7.35	4.41	3.61	4.67	4.74	9.33
1977	A	5.95	1.33	2.08	3.57	4.55	6.82
	R	7.00	3.89	2.78	5.36	4.71	9.58
1978	A	4.38	1.61	1.85	4.29	4.25	8.33
	R	7.00	3.75	3.24	5.67	4.72	9.58

RIGHT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	A	4.57	2.14	.79	2.17	4.17	6.88
	R	6.15	3.33	2.62	4.33	4.58	9.38
1977	A	3.52	1.25	-.16	2.65	3.93	7.08
	R	6.33	3.33	2.37	4.67	5.00	9.67
1978	A	3.50	1.61	1.50	2.71	2.95	7.27
	R	6.33	3.26	2.37	4.67	5.00	10.00

A: Median for annual audiogram

R: Median for reference audiogram

*MEDIAN: $Md = L + \frac{J}{F} \cdot C$

Md: Median Value L: Lower Boundary

J: # of items still to be counted after L

F: Frequency C: Interval

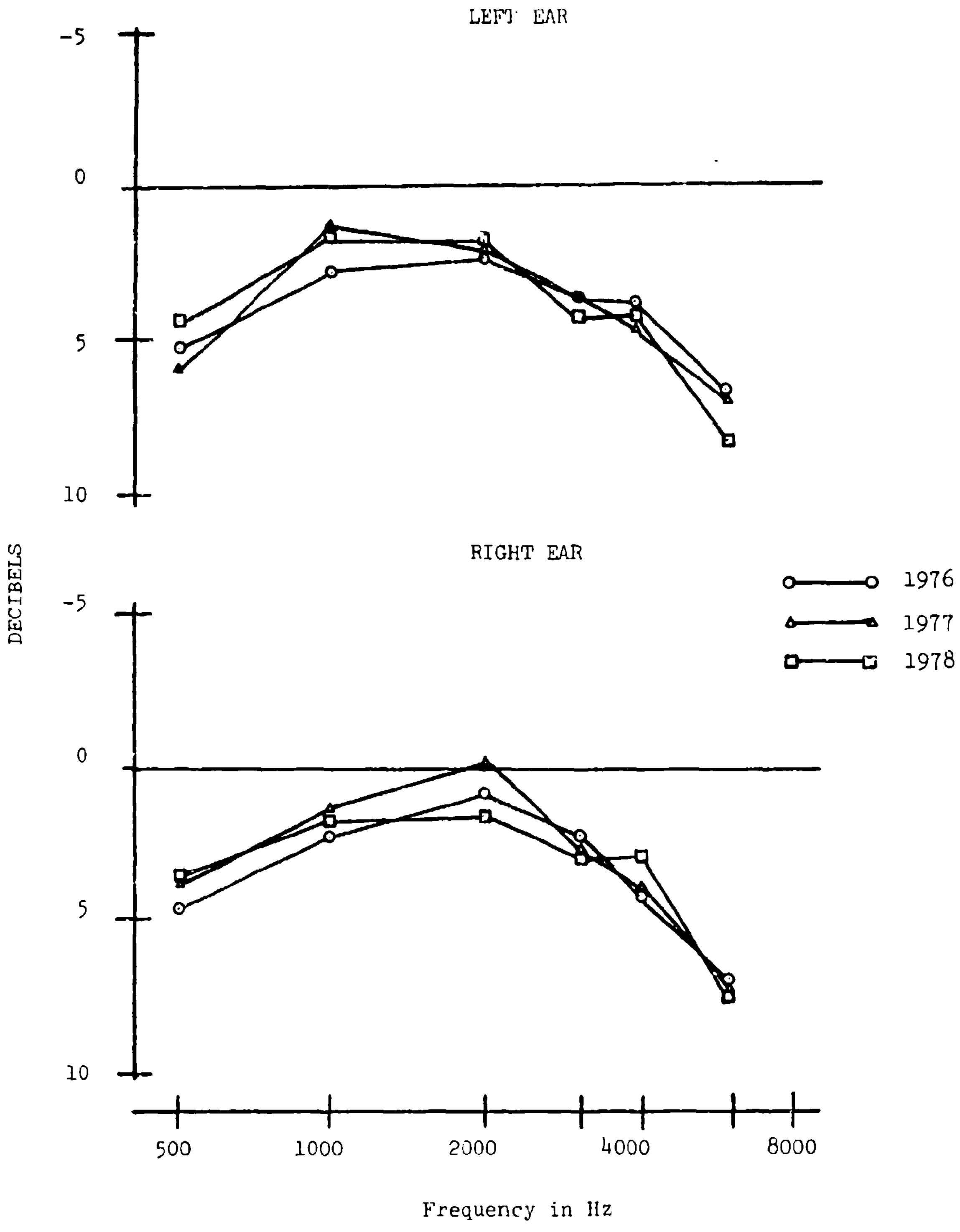

Figure 1

MEDIAN HEARING THRESHOLD LEVELS OF

FLIGHT NURSES' (N=62) ANNUAL AUDIOGRAMS

The flight nurses' age-specific mean threshold shift between the annual and the reference audiograms for the years 1976, 1977 and 1978 are shown in Table 12.

TABLE 12

MEAN* THRESHOLD SHIFT FOR

FLIGHT NURSES

IN dB

LEFT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	TS	-2.26	-0.81	-1.21	-1.29	0.08	-1.05
1977	TS	-2.26	-1.94	-0.81	-1.29	0.16	-1.21
1978	TS	-3.06	-2.02	-1.61	-0.81	-0.24	-1.45

RIGHT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	TS	-2.58	-1.61	-1.77	-2.18	0.00	-2.34
1977	TS	-3.55	-2.10	-2.26	-1.69	-0.56	-3.55
1978	TS	-3.39	-2.34	-1.61	-1.13	-0.40	-2.74

TS: Mean threshold shift between annual and reference audiogram

*MEAN: average threshold shift for total population at each frequency

On final analysis of the above tables and figures, the trend of the hearing levels of the flight nurses has shown no evidence of noise-induced hearing loss over a consecutive three year period. There is shown a slight decrease in the hearing levels at 6000Hz over the three year period in both ears (i.e., Left Ear: 6.67dB to 8.33dB --- Right Ear: 6.88dB to 7.27dB). This is possibly due to presbyacusis.

Table 13 depicts for the aeromedical technicians the median hearing levels of both the reference and annual audiograms for the year 1976, 1977 and 1978.

TABLE 13

MEDIAN* HEARING LEVELS FOR AEROMEDICAL TECHNICIANS

IN dB

LEFT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	A	6.39	3.13	2.00	4.69	9.38	9.00
	R	6.67	2.06	2.38	4.12	7.31	10.67
1977	A	6.67	4.00	2.35	6.15	7.78	10.00
	R	6.88	2.06	2.50	4.38	7.92	10.33
1978	A	5.83	2.88	2.04	5.45	6.67	11.67
	R	6.76	1.88	2.39	4.12	7.31	10.31

RIGHT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	A	4.78	3.33	2.22	3.86	7.50	6.92
	R	7.35	3.33	2.00	3.61	7.08	7.50
1977	A	4.58	3.04	1.32	3.50	6.43	7.00
	R	7.22	3.25	1.79	3.68	7.27	7.73
1978	A	4.11	2.35	2.12	3.54	[illegible].67	8.76
	R	6.94	3.25	1.43	3.68	7.27	7.72

A: Median for annual audiogram

R: Median for reference audiogram

*MEDIAN: $Md = L + \frac{J}{F} \cdot C$

Md: Median Value L: Lower Boundary

J: # of items still to be counted after L

F: Frequency C: Interval

Figure 2 depicts the median hearing level trend of the flight nurses for the years 1976, 1977 and 1978.

The aeromedical technicians age-specific mean threshold shift between the annual and the reference audiograms for the years 1976, 1977 and 1978 are shown in Table 14.

TABLE 14

MEAN* THRESHOLD SHIFT FOR AEROMEDICAL TECHNICIANS

IN dB

LEFT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	TS	0.42	1.17	-1.00	-1.67	1.92	1.93
1977	TS	0.92	1.17	-0.25	-0.58	1.50	1.67
1978	TS	-0.75	0.83	-0.67	0.67	2.08	2.83

RIGHT EAR

YEAR	TYPE	Hz500	1000	2000	3000	4000	6000
1976	TS	2.00	-0.08	-0.17	0.33	1.50	-0.33
1977	TS	-1.75	-0.25	-0.83	-0.25	0.17	-2.42
1978	TS	-1.08	-0.75	-0.17	0.50	1.33	0.42

TS: Mean threshold shift between annual and reference audiogram

*MEAN: average threshold shift for total population at each frequency

On final analysis of the above tables and figures, the trend of the hearing levels of the aeromedical technicians has shown no evidence of noise-induced hearing loss over a consecutive three year period. There is shown a slight decrease in the hearing levels at 6000Hz over the three year period in both ears (i.e., Left Ear: 9.08dB to 11.67dB --- Right Ear: 5.92db to 8.96db). This is possibly due to presbyacusis.

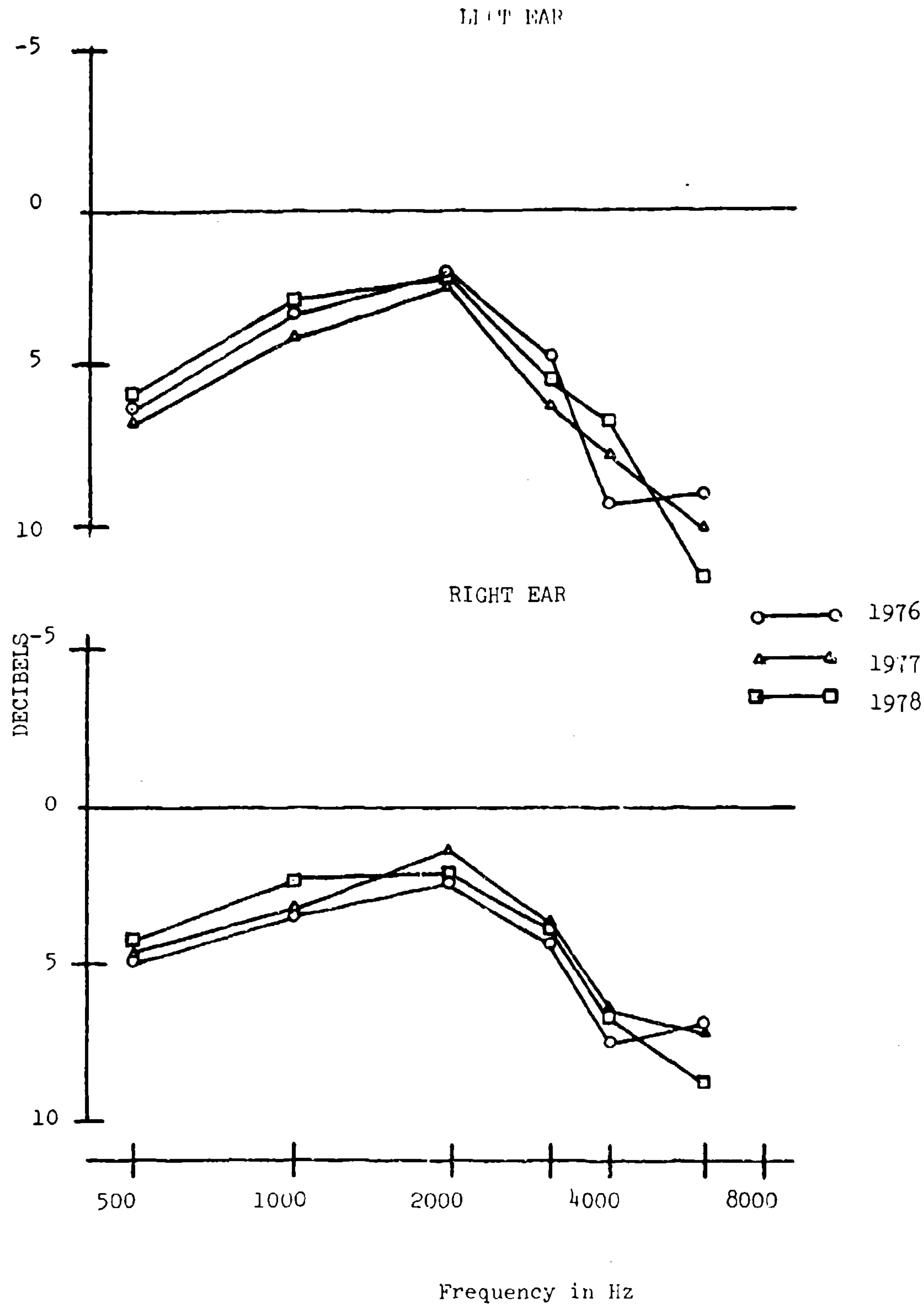

FIGURE 2

MEDIAN HEARING THRESHOLD LEVELS OF

AEROMEDICAL EVACUATION TECHNICIANS' (N=60) ANNUAL AUDIOGRAMS

On an individual basis, significant threshold shifts were depicted for those with Class B reference audiograms. On closer examination of the data, it was noted that each individual did not continue over a three year period to have a significant threshold shift. These significant threshold shifts are believed to be temporary threshold shifts although they could possibly develop with increased time into a permanent threshold shift. It is for this reason that Hearing Conservation Programs need to be increasingly aware of each individual's trend for hearing loss as the overall trend may disguise those who do have a trend toward hearing loss.

In comparing both groups, as has been shown in studies (Royster, Royster and Thomas, 1979:1), the females tended toward better hearing than the males. If the flying time had been available for the study, this may also have shown the aeromedical technicians having more flying hours than the flight nurses. This would bring about the decrease in the aeromedical technicians' hearing levels because they would be exposed to the noise environment for a longer time period. Race, also, (Royster, Royster and Thomas, 1979:1) can be a factor in the hearing levels attained. Blacks have been found to have better hearing than whites. At the present time, this information is not included in the Hearing Conservation Data Registry and could not be assessed. Therefore, it can be concluded from the information obtained that the hearing levels of both the flight nurses and the aeromedical technicians can best be described as showing no trend towards hearing loss. Rather, it shows that an overall trend towards stable hearing levels has developed over time.

CHAPTER V

SUMMARY AND CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

In an effort to describe the hearing levels of the flight nurses and aeromedical technicians, and their trend over time, a computer printout was obtained from the Hearing Conservation Data Registry, Brooks Air Force Base, Texas. The population consisted of 62 flight nurses and 60 aeromedical technicians during the period of the 1st of January, 1976 through the 31st of December, 1978.

A summary of the data indicated that both the flight nurses and the aeromedical technicians had stable hearing levels over a three year period without evidence of noise-induced hearing loss. A slight hearing loss was found for both groups at 6000Hz in the combined grouped data which could be explained possibly by presbyacusis. Both the flight nurses and aeromedical technicians had individuals with Class B reference audiograms having significant threshold shifts. Although these individuals did not show the significant threshold shifts in each consecutive year, they are believed to be at a higher risk toward noise-induced hearing loss and should be monitored more closely.

IMPLICATIONS

The following implications are made as a result of this study:

1. The USAF Hearing Conservation Program for the flight nurses and aeromedical technicians may have prevented noise-induced hearing loss.

2. Reference Class B individuals need to be monitored and observed more closely for audiogram threshold shifts.

3. USAF bases needed to be reminded of the importance of recording and reporting the data on AF Forms 1490 to the Hearing Conservation Data

Registry, USAF/SAM, Brooks AFB, Texas.

4. Re-classification of reference audiograms may cause bias which on further studies could be controlled.

5. The need to possibly explore the issue of race and sex more closely and consider each in further analyses of the USAF Hearing Conservation Program.

6. Continued awareness by those who work in hazardous noise is needed for the protection of their hearing and an understanding of the need for the USAF Hearing Conservation Program requirements.

RECOMMENDATIONS

1. This study be re-assessed and analyzed in three to five years using data over a longer time period.

2. A study to compare age, sex, race, logged flying time, type of aircraft and hearing threshold shift.

3. A study to determine the knowledge of the workers in audiogram testing facilities.

4. A study to determine the current accuracy of the audiogram testing being carried out in the United States Air Force.

5. Study could be improved by utilizing similar data for a control group.

APPENDIX A

AF FORM 1490

HEARING CONSERVATION DATA

LAST NAME-FIRST NAME-MIDDLE INITIAL	SSAN	PURPOSE FOR TEST 1. – 90 DAY 2. – ANNUAL 3. – 15 HR. RE-CHECK 4. – 40 HR. RE-CHECK 5. – OTHER (Specify)
RANK/GRADE · SEX (1-MALE, 2-FEMALE) · AGE (Yrs) · DATE OF BIRTH (DAY, MONTH, YEAR)	STATUS (1-MILITARY, 2-CIVILIAN)	
COMPLETE ADDRESS/ORGANIZATION-ASSIGNMENT	DUTY PHONE	CODE
AFSC/JOB CODE (Job Title)	TIME IN CURRENT JOB: MONTHS · YEARS	
PRIMARY NOISE EXPOSURE (1-FLIGHT LINE, 2-SHOPS, 3-OTHER) · DESCRIBE DUTIES IN NOISE	DATE INITIAL ASGN TO NOISE DY: MONTH · YEAR	

AUDIOMETRIC DATA

AUDIOMETER	STANDARD	DATE OF AUDIOGRAM	DAY OF WEEK	HOUR OF DAY AUDIO GIVEN	ESTIMATE OF HEARING	CLASS OF REFERENCE (Audiogram)
1-MANUAL 2-AUTOMATIC	1-ANSI S3.6 2-OTHER (Specify)	DAY · MONTH · YEAR	1-SUN 2-MON 3-TUE 4-WED 5-THU 6-FRI 7-SAT		1-GOOD 2-FAIR 3-POOR	1-A 2-B 3-C

EAR	LEFT						RIGHT					
FREQUENCY (Hz)	500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
CURRENT AUDIO												
REFERENCE AUDIO (Corrected to ANSI S3.6)												
THRESHOLD SHIFT += POORER -= BETTER												

FINDINGS (Significant T.S.)		DISPOSITION
NO	YES	☐ RETURN TO DUTY ☐ FOLLOW-UP REQUIRED (☐ 15 HOUR ☐ 40 HOUR ☐ OTHER)

PERSONAL EAR PROTECTION

EAR PLUGS (Insert Devices)	DEVICES WORN BY INDIVIDUALS	GLASSES (Including Safety)	PROTECTION CONSIDERED
1-INITIAL ISSUE 2-RE-ISSUE 3-NOT ISSUED	1-PLUGS 4-PLUGS AND MUFFS 2-MUFFS 5-OTHER 3-PLUGS OR MUFFS	1-YES 2-NO	1-ADEQUATE 2-NOT ADEQUATE

REMARKS

DATE	TYPED NAME OF EXAMINER	AFSC	SSAN	OFFICE SYMBOL

APPENDIX B

AUDIOGRAM STANDARDS

AUDIOGRAM STANDARDS

Frequency (Hz)	500	1000	2000	3000	4000	6000
H-1 Profile each ear (dB)	25	25	25	*	*	*

Reference Class A--Hearing Threshold Level (HTL) of 25dB or better, all frequencies, both ears.

Reference Class B--HTL of 30dB or poorer at any frequency, either ear, but not Class C.

Reference Class C--Average HTL for 500, 1000, and 2000Hz is 30dB or poorer, either ear (total HTL of 90dB or more for 500, 1000, and 2000Hz, either ear).

*No more than a total of 270 decibel loss for both ears at 3000, 4000, and 6000Hz. (Average of 45dB for the six thresholds.)

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VITA

Mary Gene Guzinski Ryan [redacted] PII Redacted

[redacted]. After completing her work at the George J. Penney High School, East Hartford, Connecticut, in 1971, she entered Southern Connecticut State College at New Haven, Connecticut, and received her Bachelor of Science degree with a major in nursing and a minor in speech pathology on May 24, 1975. During the following year, she was employed at the University of Connecticut Health Center as an obstetrical nurse. In August of 1976 she was commissioned as an officer in the United States Air Force Nurse Corps and was first assigned to Williams Air Force Base, Arizona as a Medical-Surgical-Pediatric-Psychiatric nurse. After completing a five-week flight nurse course in May of 1977, she was later assigned to the 2nd Aeromedical Evacuation Squadron at Rhein Main, Germany as a flight nurse and because a flight nurse instructor in Sept. 1978. She was promoted to the grade of Captain on February 1, 1979. She co-authored a paper titled "The European Inter-Intra Theater Aeromedical Evacuation System: - Our Mission - Our Attempt." which was published in the Aviation, Space and Environmental Medicine Journal in March, 1980. On June 9, 1979 she married Robert Eldon Ryan, III of New Orleans, Louisiana. She is currently on active duty with the United States Air Force in San Antonio, Texas.

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This thesis was typed by: Madelyn L. Jones